

Energy—Its Forms and Interactions Teacher Background Information (SC040200)

For students and adults alike, energy is a difficult concept to define. It does **not** have mass and take up space, as matter does. Often young students hold the misconception that energy is a form of matter.

Students can, however, easily observe the effects of energy and its interaction with matter. Scientists often define energy as the capacity to do work or to cause change. When teaching elementary students, it is important that the term, “work,” is used as a generic word and not as the more specific physical science concept ($\text{work} = \text{force} \times \text{distance}$; That can come later).

Students may respond to the question, “Where did the energy go?”, by answering, “It was lost.” The Law of Conservation of Energy tells us that energy can be neither created nor destroyed (lost). It is not developmentally appropriate to introduce or discuss this Law. Understanding it depends upon knowledge of higher-level physics. It is, however, important that students observe that there are different forms of energy and that one form of energy can be transformed into another form of energy. So while students may think that energy is lost, it is often true that in those instances, energy has been transformed.

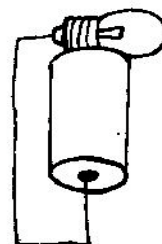
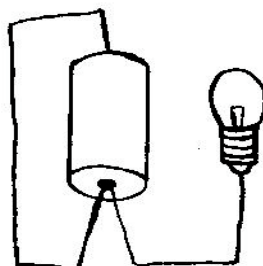
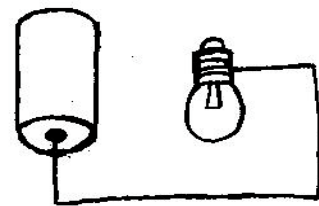
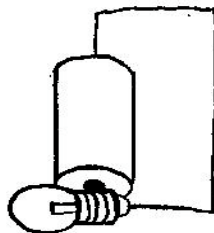
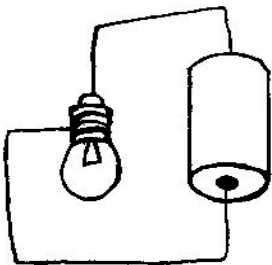
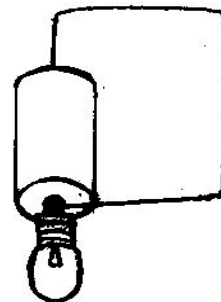
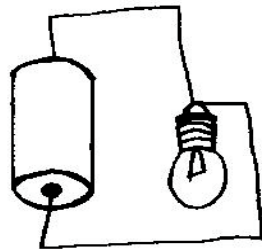
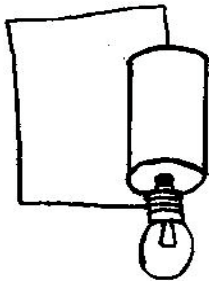
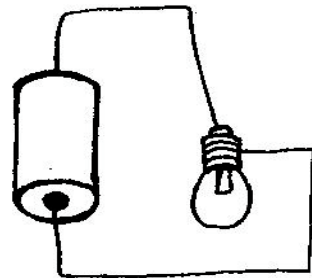
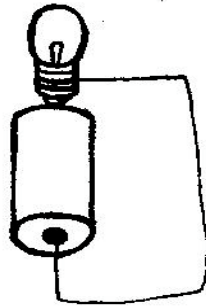
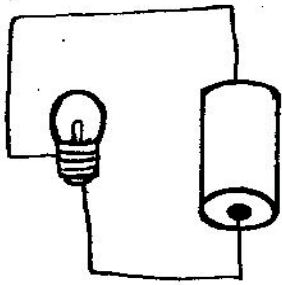
Batteries and Bulbs

By the time students have reached fourth grade, they will have had many experiences with electricity or electrical energy. The toast they eat in the morning, the television they watch, and the warnings not to touch electrical cords provide students with an intuitive sense about electricity and its capacity to do work.

Research into how students learn this concept reveals that many students believe that there is an energy source (such as a battery) and that electricity somehow flows from it to an energy consumer, such as a bulb or motor. This thinking is evident when students begin to try and light a bulb using a battery and wire—they often run a wire from one end of the battery to the bulb.

Students need time to construct their understanding that for electricity to do useful work it needs to flow along a path or circuit. It is not helpful to introduce the word “circuit” until students have had many opportunities to construct different kinds of circuits. Students in their early experience with bulbs and batteries may describe a circuit as a path or circle for electricity to follow. At this point in their development, it is inappropriate to introduce students to electron flow or any aspect of electricity at the atomic level.

Assessment Transparency



Form of Energy Stations

Form of Energy	Material at Station	Procedure	Interaction of Energy & Matter
Light	Flashlights and a radiometer	Students shine the flashlight onto the radiometer.	Light energy causes the radiometer to spin (energy of motion).
Heat	Hot plates and beakers of water	Students heat the beaker of water to boiling.	Heat energy provided by the hot plate causes water to boil (energy of motion).
Sound	Tuning forks, pie plates and water	Students make the tuning forks vibrate and then place the prongs in water.	Sound energy in the form of vibrating tongs causes the water in the pie plate to splash (energy of motion).
Wind	Electric fan and pinwheels	Students turn on the fan and direct the wind from the fan onto pinwheels.	Wind energy produced by the fan caused the pinwheels to turn (energy of motion).
Motion	Ruler	Students make the end of a ruler vibrate.	The energy of motion in the form of a vibrating ruler produces sound (sound energy).

Heat Energy

We “feel” heat from the sun, from the heater of a car, or even from the person sitting next to us, but what is heat, really? Students, by the time they have reached fourth grade, have had a lot of experience with heat energy as they have watched water boil, ice cream melt, or seen icicles dripping from the roof on a sunny winter day. Heat energy moves or is transferred from warmer objects to cooler objects. One of the misconceptions that students harbor is that objects such as melting ice cubes lose their cold instead of gaining heat energy. At this age, students need not relate heat energy to motion or activity of atoms. They can, however, experience and begin to understand how heat is transferred through radiation, conduction, and convection.

Radiation in the form of sunlight was the focus of Lesson 5. (See the Teacher Resource file for that Lesson for more information about radiation.) *Conduction* is the process by which heat is transferred through solid material. Examples of this in the real world would be heat transferred from a burner to a metal pan, or from a warm person to a cold person. *Convection* is the movement or transfer of heat through liquids and gases. Cold water on the stove eventually becomes hot water through convection or movement of heat energy through the water. Heat energy created by a burner in a hot air balloon is transferred to the air inside the balloon.

In Lesson 6, students will experience conduction and convection through the activities involving the plastic bags and foam cups. From Lesson 6, students will have gained experience with convection or the movement of air that helps to transfer heat energy. Insulation impedes this movement of air by trapping it in pockets. In Lesson 7, students experiment by testing the capacity of different types of insulation to control the transfer of heat out of a model of a model house (a shoebox).

Energy Consumption

Members of our society consume a huge amount of energy. One can think of dozens of ways in which we use electrical and heat energy each day. The fuel that powers our cars, the electricity that lights our homes and schools, and the natural gas that heats our buildings are all examples of energy consumption that we take for granted.

Sources of energy for these many uses include fossil fuels (e.g., coal, oil, kerosene, natural gas, and liquid propane), nuclear power, and hydroelectric dams.

When burned, fossil fuels emit carbon dioxide (CO₂) into the atmosphere. Carbon dioxide in large amounts has been found to cause global climate change, also known as “the greenhouse effect.” When carbon dioxide and the other products of fossil fuel combustion (namely, water vapor and methane) build up in the atmosphere, they trap heat within the inner layers of the earth’s atmosphere. Heating that results when light energy enters the interior of a closed car on a sunny day provides a familiar if not exactly comparable example of the greenhouse effect: light energy enters the earth’s inner atmosphere, and is transferred to heat energy. Just as the closed windows of the car keep the heat energy inside the car, the build-up of “greenhouse gasses” in the atmosphere prevents the heat from escaping from the earth’s atmosphere. Many scientists caution that the warming of the earth from this additional heat will cause — or perhaps is already causing — global climate change. Climate change could have devastating results, such as

flooding, melting of the polar ice caps, changes in the range of some plants and animals, and altered distributions and life history strategies of disease-causing organisms. While there is evidence that the earth is experiencing a warming trend, there are some scientists and other citizens who believe that this warming trend is a natural phenomenon.

The burning of fossil fuels also results in the release of particulates (sulfur oxides and nitrogen oxides) into the atmosphere. These pollutants can cause additional problems, such as acid rain and respiratory distress. In addition to these physical realities, political tensions are heightened around the issues of energy supply and energy consumption. Plants that burn fossil fuels currently produce about 80% of the total amount of electrical energy used in the United States.

Nuclear power creates thermal pollution (the heating of water around nuclear plants). The production of nuclear power also creates radioactive waste. This waste may remain harmful for thousands of years. Disposal or storage of nuclear wastes has been an issue of contention around the world for many years.

Many communities obtain electrical energy from turbines that are turned by water that flows through hydroelectric dams. Production of energy in this manner also has environmental impacts. Changing the course of waterways, often a necessary step in the construction and maintenance of hydroelectric dams may harm the aquatic ecosystem. Species and whole ecosystems have become extinct as a result of hydroelectric dams.

Energy use in the United States is very high compared to energy consumption in other countries. As a result, many negative effects of energy use are apparent in the United States. Energy conservation can be a very productive and interesting path for students to examine. First, students need to learn where and how the energy used to run their school is generated. Then they can begin to study the consumption of energy in their school, and develop suggestions for reducing it. Lessons 9 and 10 engage students in this work.

Students can also take the opportunity (in Lesson 8) to learn about alternative (sometimes called renewable) energy sources. These include both passive and active solar energy and generation by the wind.